

July 22, 2003

Prof. Raj Gandhi
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Dear Dr. Raj Gandhi:

It was a pleasure to have you as a seminar speaker a few weeks ago. In your seminar, you described your ideas on the Indian Neutrino Observatory (INO). In this letter, as you requested, we would like to provide you some feed-back on the plan you described as well as some broader issues.

To begin with, we are very encouraged by your plan to perform an experiment to show neutrino oscillations in a definitive way by measuring L/E for atmospheric neutrino interactions. We feel that, irrespective of the detector choice, this is clearly the next step for neutrino physics. We were also intrigued by your choice of deep underground locations. We would like to know more about the possibility of building large caverns at these locations.

We would like to understand your choice of a magnetized iron calorimeter as the detector of choice. As usual there are positive and negative aspects to detector configuration, and therefore it is important to address possible concerns.

First is the issue of the efficiency for measuring neutrino events in a magnetized iron calorimeter, which is a strong function of direction as well as position. Therefore this technology must be used with care for diffuse sources such as atmospheric neutrinos. In fact, MINOS is having some difficulty in collecting well-measured contained atmospheric neutrino events. The analysis required for selecting such events in MINOS has become rather complicated. That level of complexity is not desirable for INO, which has atmospheric neutrino detection as its prime mission.

Secondly, a deep underground location naturally allows one to collect events at low energies with very little background. This feature has been utilized with great success by successive water Cherenkov counters. An iron calorimeter, unfortunately does not utilize this essential advantage. The thickness of the iron and the strength of the magnetic field will probably limit the capability of a magnetized iron calorimeter to a relatively narrow energy window. This range should be evaluated.

In your seminar, you emphasized that INO, located in India, could be the detector for a neutrino factory based beam from Japan. The oscillation distance and the detector mass could be appropriate for such an experiment. Nevertheless, it is very important to understand how one could satisfy both the goals of a neutrino factory and atmospheric neutrino detection

with a magnetized iron detector. It also appears that a complete measurement program with a neutrino factory will require a detector with capability to measure events with e.m. showers as well as multiple particles. Such capability will increase the scientific breadth of INO, if possible.

Lastly, it is important to look at the historical record of achievement for iron based calorimeters. The most important achievement of this technology could be the detection of atmospheric neutrino events in the Kolar mine in the 1960's. But apart from that discovery, this method has lagged behind other methods, in particular, the water Cherenkov method. It now appears very likely that a very large water Cherenkov detector will be built somewhere in the world. Such a detector could also have new capabilities: better timing, better imaging and event reconstruction, etc. It is very important that any future iron calorimeter detector concept be compared against such a project.

We understand that despite these concerns, as well as manpower and funding limitations (discussed in a recent article, *Pramana*, Vol. 55, July 2000) a large magnetized iron detector such as INO could have a role to play. To define this role as well as implement it in a timely way, it is important to vent these ideas at international workshops such as the ones presently planned in the U.S. (We were informed, recently, that a workshop might be arranged in India in November.) We hope that one outcome of these workshops is increased participation in each other's projects for mutual benefit. Such an interaction is, in our opinion, extremely valuable in the long term.

We also suggest that when your ideas on INO become better understood, you convene an international committee to discuss the scientific and technical merits of INO. Such a committee could also be charged with suggesting new uses for the deep underground site and avenues for international participation in your project.

Sincerely,

Nicholas P. Samios

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